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LIMITING FACTORS IN THE MECHANISATION OF MINES UNDER CONDITIONS PREVAILING IN LESS DEVELOPED AREAS

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LIMITING FACTORS IN THE MECHANISATION OF MINES UNDER CONDITIONS PREVAILING IN LESS DEVELOPED AREAS

David L. Warrender.

1. INTRODUCTION

This paper is based on the author's experience in the Enugu coal mines of the Nigerian Coal Corporation, and a general description of the coalfield and conditions therein, while not essential to the subject matter, is included in the paper, as it is felt that this may help the reader to gain a better understanding of the conclusions drawn. Again, it is not the author's intention to compile masses of statistics, but simply to give his opinions, along with the reasons for same, based on practical knowledge and experience.

The coalfield is situated in the Eastern Region of Nigeria in close proximity to Enugu, the capital of the region, which owes much of its growth to the coal industry. The coal seams, geologically speaking, are of fairly recent origin, and have not yet been extensively proved, except in the area of outcrop along which the mines are situated. Coal mining began in the year 1916, and at that time was under the control of the Nigerian Railways, as the coal was mined principally as a fuel for steam locomotives. Nowadays, the responsibility for mining the coal rests with the Nigerian Coal Corporation, which operates four mines. Output is in the region of 650,000 to 700,000 tons per annum, and is mainly supplied to Nigerian Railways and the Electricity Corporation of Nigeria for use in power stations, although an increasing market is gradually being developed with smaller industries, such as cement factories, canning factories etc. and some coal is exported to Ghana. Although six different seams have been proved, only one is of workable thickness. The seam being worked varies in thickness between 4'0" and 7'0" and is troubled by slight undulations, although generally it can be considered as flat.

The mines worked at present are situated along the outcrop of the seam, and the coal is worked from surface drifts driven into the hillside along which the outcrop occurs. The workings themselves are relatively shallow, the depth from the surface rarely exceeding 500 feet and more often in the nature of 200 ft. to 300 ft. Due to the shallowness of the working, no great roof pressures are experienced. The labour used in the mines comes entirely from the local population, and the supervisory and technical staff was previously composed mainly of expatriate officers, but in recent years, most of the responsibility for management and administration has been taken over by experienced and qualified Nigerian technicians, many of whom have received overseas training, after gaining initial experience locally.

2. THE APPLICATION OF MECHANISATION UNDER THE PREVAILING MINING CONDITIONS

The term, prevailing mining conditions, is intended to include geological conditions, suitability of the present systems of working for adaptation to mechanised mining, capacity of officials and workmen to learn new techniques and the marketing requirements with regard to size and quality of the product. Before any decision can be taken with regard to the introduction of mechanisation, a detailed survey must be undertaken to decide:

(a) The types of machinery and the method of working best suited to conditions. The knowledge and experience for making this decision is not normally available in less developed areas, as mining practice is progressing at such a rate in more advanced countries, that the mining engineer overseas finds it increasingly difficult to keep up to date with modern methods. Recommendations must therefore be obtained from a body which is specialised in this field.

(b) Reconstruction work which may be required at existing mines, particularly with regard to haulage and ventilation systems, before the benefit of complete mechanisation would be felt.

(c) The need for laying out a new mine or mines. It may be possible, by the introduction of extensive mechanisation, to delay or even cancel the development of new mines, which have been scheduled for the increase or maintenance of output.

(d) The need for screening and washery plant depending on the requirements of the market.

The application of mechanisation would normally proceed slowly initially for the following reasons, firstly, there is a shortage of technicians to work and maintain machinery on a large scale. Secondly, there is a shortage of trained supervisory staff to enable mechanised mining to be operated successfully. Thirdly, the workmen themselves must be trained in new methods. All these considerations may be overcome by the importation of trained personnel for a limited period, but the cost of maintaining such a group of specialists may well prove to be prohibitive, unless subsidised from outside sources.

3. ECONOMIC CONSIDERATIONS

It must be assumed that mechanisation will only be introduced for one of the following reasons:

(a) To reduce the cost of production by increasing efficiency and reducing labour costs. If mechanisation is introduced purely to reduce the cost of production, and assuming that no overall increase in production is required, then the following factors have to be considered:

(i) The amount of capital outlay required. This would vary considerably depending on the type of machinery required and reconstruction work which might need to be carried out at older mines. With special regard to coal mines, it is an established fact that the percentage of small coal and fines increases with face mechanisation, and if a dirt-band occurs in the seam, the amount of stone in the run-of-mine product again increases. This would require additional capital expenditure on coal screening and washery

machinery where these are not already established.

(ii) Additional staff will have to be employed and trained for machine maintenance and overhaul. Power costs, which are often very high in a rapidly developing country must be considered. All machinery and spares for such machinery must be imported. This will involve high freight charges, and also means that the stock of spare parts normally held by agents or manufacturers, must be stored by the mining concern, which again means capital outlay.

(iii) Where there is an extensive mechanisation programme visualised, the workers must be thoroughly trained to operate and maintain the machinery if the full benefit of mechanisation is to be gained. This will mean the short-term employment of a team of experienced, practical instructors and demonstrators, whose services will not come cheaply.

(iv) All of the foregoing items must be set against the saving in labour costs gained by the increase in efficiency and consequent redundancy of labour. In a less developed area, the wage rate per unit of production is low compared with more developed area, and will not increase to any great extent until the area becomes fully industrialised, with resultant full employment. Experience has shown that the economic advantage gained by the introduction of mechanised mining is almost wholly offset by the increase in maintenance and running costs.

(b) To increase production from a given number of mines. The main economic consideration in this case, is whether the development of a new mine would cost less than the concentration of output from existing mines, by the introduction of mechanisation.

(c) A combination of (a) and (b) which would be associated with long term planning and with the development of new mines. This category would come under long term planning on a national scale, and in the case of coal mining, would be based on an intensive industrialisation policy. The controlling factors would then be the availability of sufficient capital, and the rate at which output would require to expand to keep pace with the fuel requirements of industry.

4. SOCIOLOGICAL CONSIDERATIONS

The social consequences of any mass redundancy of labour in a well established industry, where alternative employment is not available and where no form of social security is in operation can be well imagined. The immediate effects may be mitigated to some extent by the payment of some gratuity or ex-gratia payment, which would be added to the cost of mechanisation, but eventually, the remainder of the community must absorb and support the retrenched labourers. This inevitably means a reduction in the standard of living of the community as a whole.

One of the more important, and at the same time, uncertain aspects of introducing mechanisation in mining, is the need for good industrial relations between men and management. Miners are a very conservative group when faced with new ideas and techniques, and good industrial relations must exist if anything new is to be introduced successfully. Good industrial relations can only exist if the management is fully acquainted with, and sympathetic towards local customs

and traditions. Therefore, the management should consist of people who are native to the area, or who have spent a considerable time living and working in the country.

5. TRAINING FOR MECHANISATION

This is the most important factor in introducing mechanisation. The training programme must be carefully and expertly prepared and may be divided into the following categories:

(a) Training of Labour. The basic training of the labour force must of necessity be carried out on the job by experienced practical demonstrators and supervisors, and should consist, at least initially, of step by step instruction in a rigid and timed system of working, which has been planned beforehand. The training programme may also be supplemented by mass lectures and film shows, showing how the machine should work and the various stages of the work.

(b) Training of Engineering, Maintenance and Repair Staff. Modern mining machinery and controlling apparatus is very often of a highly complex nature, and every engineer who is in any way responsible for maintaining or repairing such machinery, must have a basic theoretical knowledge of his particular branch of engineering. Before this knowledge can be assimilated and understood, he must have a good background of general education. This background which should be up to Secondary Education standard, will often be lacking in a less developed area, and presents one of the main obstacles in the whole scheme. The training of the craftsmen must therefore begin a considerable time before the introduction of mechanisation takes place. The practical side of the instruction course will again be carried out on the job.

(c) Training Supervisory Staff. Again, the instruction would be mainly practical, with a series of lectures, mainly pertaining to safety. It would be of considerable advantage if these instructors and demonstrators could have some knowledge of the language and local customs. In other words, if they could consist of people who already have mining experience in this particular area.

(d) Training of Management and Executive Staff. Mechanisation brings with it into top management, a series of highly specialised jobs in all departments, and training for these jobs can only be obtained in an area or country where mechanisation is already accepted practice, unless the introduction of mechanisation is to be a relatively slow process.

6. THE NEED FOR A GUARANTEED MARKET, PREFERABLY CLOSE TO THE COALFIELD.

As the introduction of mechanisation in mining will be part of a long term policy, due to the amount of capital expenditure involved, it follows that this money will not be spent unless there is a guaranteed return of capital from the sale of the mineral produced. In the case of coal which is faced with growing competition throughout the world from other sources of fuel, in particular fuel oil, the proximity of the consumer to the coalfield is of the utmost importance, for two reasons, mainly the excessive cost of freight charges for the bulk transportation of the mineral, and very often, the uncertainty of the facilities for long-distance haulage in less developed areas. Where there has already been a considerable amount of industrial development in the area, the market will be already established, but if mechanisation is being contemplated in the hope of expanding the market, then there must be a guarantee that coal consuming industries

will be introduced, and that they will continue to use the mineral as a fuel over an extended period. This may only be accomplished as the result of having nation fuel and industrialisation policies which are closely linked.

7. FUTURE PLANNING

Planning for the future of any mining area will be considerably altered by the decision to introduce mechanisation, viz.

(a) Planning of New Mines. With the concentration of output that mechanisation will bring, it should be possible to increase the output from existing mines, or to maintain the existing level of output from fewer mines. In either case, it will very probably entail the postponement of plans for the development of new mines.

(b) Planning New Systems of Working. New methods of working the mineral will be employed, and this must mean re-planning of existing and future district layouts.

(c) Planning New Training and Educational Schemes. Too great an emphasis cannot be placed on the need for proper training of all grades of workers in the industry, from labourers to the top executive ranks. All existing training schemes will require to be re-organised, and new schemes instituted where necessary to cope with the new trends and ideas.

(d) Planning for New Markets. Mechanisation in the coal industry brings with it a degradation in the size of the end product. Existing markets must be warned of any impending changes and new markets have to be introduced which will use the type of fuel available.

(e) Planning for Extensive Stock-Piling Facilities. Machines can only be economical if they are kept producing. In a fluctuating market, the only means of maintaining a planned output over considerable periods, is to hold sufficient stocks to cushion the differences in demand.

8. CONCLUSIONS

(a) The introduction of mechanisation must be accomplished by meticulous planning, if the full benefits are to be felt.

(b) Where possible, the introduction should be made gradually to allow sufficient time for the workmen to become accustomed to the machines, and in particular, to allow maintenance staff to receive proper instruction.

(c) The main considerations will be of an economic nature, but the introduction of mechanisation should not be allowed where a large percentage of the labour force may be declared redundant, if alternative employment cannot be made available. At the same time, the availability of a disciplined labour force may influence the setting up of new industries.

(d) The introduction of mechanisation requires the expenditure of a vast amount of capital, and guaranteed markets with expected returns over long term periods must be foreseen.

(e) Although complete mechanisation may not be considered expedient, mechanisation should be carried out on underground haulage and conveying systems, particularly at bottlenecks, in order to eliminate delays due to the human factor.

(f) Mechanisation would also be recommended in the development of new mines, where speed means money, in the sense that the mine would become a productive unit more quickly.

(g) The design of the machinery and control apparatus should be kept as simple as possible, at the same time, complying with local conditions and safety regulations.

(h) Where the mining concern or company is not very large, the output from one machine may represent a considerable portion of the total output, therefore, if the machine is to be kept working at maximum output, a stable market is essential, unless considerable stocks of the mineral can be held. This may not be possible, if for instance, the product is subject to rapid deterioration.

(i) Training in general for all personnel, from labourer to executive, should be carried out under local conditions, although a certain amount of intensive overseas training may be unavoidable, particularly with regard to the specialist jobs such as planned maintenance, cost control and management techniques, which follow mechanisation.

(j) Where mechanisation is envisaged in the future, experiments with various systems of working and roof control should be instituted, and as much factual data as possible accumulated against that time.

(k) Every effort should be made to instal any piece of machinery or equipment which improve the health, safety and working conditions of the workmen.

NOTE: The opinions expressed in this paper are those of the author, and are not necessarily those of the Nigerian Coal Corporation.

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